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Robert W. Lenz

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Amherst, MA 01003

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13. ABSTRACT (Maximum 200 words)

A grant of $2,500 from the Army Research Office was used to provide financial support for the travel and registration expenses of 8 researchers from American universities (including 4 faculty members and 4 graduate students) to participate in the 4th International Workshop on Biodegradable Plastics and Polymers. The workshop was held in Durham, New Hampshire on October 11 - 14, 1995. The total attendance was 178 conferees including representatives from 14 countries. The program included 31 lectures and 69 poster presentations. All of the recipients of financial support from the grant participated actively in the program either as speakers, in poster presentations or in the operation of the workshop.

14. SUBJECT TERMS
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FINAL REPORT
to the
ARMY RESEARCH OFFICE
on
GRANT No. DAAH04 - 95 - 1 - 0643

for the
Partial Support of the
4th INTERNATIONAL WORKSHOP ON
BIODEGRADABLE PLASTICS AND POLYMERS
DURHAM, NEW HAMPSHIRE

Submitted by
Professor Robert. W. Lenz, Conference Co-Chair
Polymer Science and Engineering Department
University of Massachusetts, Amherst
Amherst, MA 01003
March 1996

SUMMARY

A grant of $2,500 from the Army Research Office was used to provide financial support for the travel and registration expenses of 8 researchers from American universities (including 4 faculty members, and 4 graduate students) to participate in the 4 th International Workshop on Biodegradable Plastics and Polymers. The workshop was held in Durham, New Hampshire on October 11 - 14, 1995. The total attendance was 178 conferees including representatives from 14 countries. The program included 31 lectures and 69 poster presentations. All of the recipients of financial support from the grant participated actively in the program either as speakers, in poster presentations or in the operation of the workshop.

INTRODUCTION

A grant of $2,500 was awarded to the University of Massachusetts, Amherst by the Army Research Office, ARO, for the partial support of the 4 th International Workshop on Biodegradable Plastics and Polymers. The Workshop was held on the campus at the University of New Hampshire in Durham during the period of October 11 - 14, 1995. Professor Robert W. Lenz of the Polymer Science and Engineering Department was Co-Chair of the Workshop.

The purpose of the grant was to provide financial assistance to young researchers from American universities to help cover the costs of the registration fees and travel expenses. The recipients were either graduate students or younger faculty members, and each was committed to participating in the program as either a speaker , in a poster presentation or in the operation of the Workshop.

PROGRAM

The program of the workshop included 31 lectures and 69 poster presentations. A copy of the Workshop program listing speakers, discussion leader, lecture titles and poster presentations is given in Appendix I. The principal subjects of the lectures and posters were the following:

(1) New Degradable Polymers

(2) Processing Biodegradable Polymers

(3) New Characterization Methods for Biodegradable Polymers and Biodegradation

(4) Biodegradation Methods and Safety Assessments

(5) Regulation and Disposal

ATTENDANCE

The attendance list, which was distributed by the conference office, is given in Appendix II. The 178 conferees included representatives from 14 countries, including Austria, Belgium, Canada, England, Finland, France, Germany, Italy, Japan, Korea, the Netherlands, Poland, Sweden and the United States.

PARTICIPANTS SPONSORED BY ARO GRANT

The funds from the ARO grant were used to cover either part or all of the registration fees, meals, housing and travel expenses of 4 graduate students and 4 younger faculty members from American universities as indicated in the list below. Three of the faculty members (Browne, Nosker and Bartha) presented lectures and one (Jane) was involved in the organization of the Workshop. All four of the graduate students were involved in poster presentations. The names, affiliations and funds allotted for each of the recipients of ARO support are as follows:

Name	Position	University	Amount Received, $
R. Bartha	Faculty	Rutgers	400
S. Browne	Faculty	Mt. Holyoke	350
J. -L. Jane	Faculty	Iowa St.	400
T. J. Nosker	Faculty	Rutgers	250
R. A. Kumar	Grad. Stud.	UMass, Lowell	200
M. Lostoco	Grad. Stud.	Connecticut	350
R. Mac Donald	Grad. Stud.	UMass, Lowell	200
T. Scherer	Grad. Stud.	UMass, Amherst	350
		Total	$2,500

Appendix I

PROGRAM AGENDA

Wednesday, October 11

11:00 a.m.-1:00 p.m.	REGISTRATION–New England Center Gallery
1:00-5:00 p.m.	TUTORIAL SESSION: WASTE DISPOSAL METHODS AND RESOURCE RECOVERY *Organizer:* Richard Gross

- Thomas J. Nosker, *Center for Plastics Recycling Research*
  Commingled Plastics Recycling Technology

- Jose M. Sosa, *Fina Oil Chemical Company*
  Reclaiming High Value Chemicals from Waste Plastics

2:45-3:15 p.m. COFFEE BREAK

- Geoffrey A. Kuter, *Wheelabrator Clean Water Systems, Inc.*
  Composting Technology and Infrastructure for Biodegradable Plastics and Polymers

- Michael M. Fisher, *American Plastics Council*
  Resource Recovery Economics for Post-Consumer Plastics–Complex, Variable, Relative, Local

- Bert Lemmes, *Organic Reclamation and Composting Association, Belgium*
  The Future of Biodegradables in a Sustainable Household Waste Policy

7:00-10:00 p.m. RECEPTION AND REGISTRATION

Thursday, October 12

7:00-8:00 a.m.	BREAKFAST–Woods Restaurant
7:30-9:30 a.m.	REGISTRATION–New England Center Gallery
8:30-Noon	SESSION 1: **New Degradable Polymers** *Organizers and Co-Chairs:* Emo Chiellini, Yoshiharu Doi, Richard Gross, Alex Steinbuchel
	• A.J. Pennings, *University of Groningen, Department of Polymer Chemistry, The Netherlands* **Biodegradable Polymeric Materials for Meniscus Repair in Internal Fracture Fixation**
	• Yoji Hori, *Central Research Laboratory, Takasago International Corp., Japan* **Synthesis of New Biodegradable Polymers by Ring-Opening Copolymerization**
9:30-9:45 a.m.	COFFEE BREAK
	• Masao Kunioka, *National Institute of Materials and Chemical Research, Agency of Industrial Science and Technology, Japan* **Biodegradable Hydrogels Prepared from Microbial Poly(γ-glutamic acid) and Poly(ε-lysine)**
	• Lee A. Schechtman, *The Procter and Gamble Company, Miami Valley Laboratories, USA* High-Yield Synthesis of Poly(3-Hydroxybutyrate) of Well-Defined Molecular Weight
	• Rolf-J. Müller, *GBF, Germany* **Biodegradable Synthetic Polyesters Containing Aromatic Compounds**
Noon-1:00 p.m.	LUNCH–Woods Restaurant
1:30-4:00 p.m.	SESSION 2: **Processing Biodegradable Polymers** *Organizers:* Stephen McCarthy, Ned Thomas, Mike Cox, Yutaka Tokiwa
	• Chris Ryan, Cargill, USA **Processing Considerations and Applications for Poly(Lactic Acid)-Based Polymers**
	• Vipul Davé, *Warner-Lambert, USA* **Solution and Melt Processing of Biopolymers**

- Takashi Fujimaki, *Showa Highpolymer Co., Ltd., Japan*
  Processability of a New Biodegradable Aliphatic Polyester "BIONOLLE"

3:00-3:15 p.m. COFFEE BREAK

- Catia Bastioli, *Novamont, Italy*
  Processing and Properties of Biodegradable Composite Materials Based on Starch

- Yutaka Tokiwa, *National Institute of Bioscience and Human Technology, Japan*
  Comparison of Starch Species on Physical Properties of Starch and Polycaprolactone Blends

- Stephanie Simmons, *Massachusetts Institute of Technology, USA*
  Morphology of Starch Poly(Ethylene-Vinyl Alcohol) Thermoplastic Blends

4:30-6:00 p.m. SESSION 3: **Poster Session A**

6:00-7:30 p.m. DINNER-Woods Restaurant

Friday, October 13

7:00-8:00 a.m. BREAKFAST–Woods Restaurant

8:30-Noon SESSION 4: **New Characterization Methods for Biodegradable Polymers and Biodegradation**
Organizers: Bob Marchessault, Michel Vert, Sam Huang, Richard Wool

- Sheila Browne, *Mount Holyoke College, USA*
  Monitoring The Formation and Degradation of Poly(b-hydroxyalkanoates), PHA's, *In Vivo* using Natural Abundance ^{13}C-NMR Spectroscopy

- Alberto Ballistreri, *Universita degli Studi di Catania, Catania, Italy*
  Characterization of Bacterial Poly(3-hydroxyalkanoates) by Mass Spectrometry Analysis of their Degradation Products

9:30-9:45 p.m. COFFEE BREAK

- Philippa J. Hocking, *McGill University, Canada*
  Methods for Characterizing the Enzymatic Degradability of Synthetic PHB

- Christian Braud, *CNRS, France*
  Capillary Electrophoresis to Monitor the Formation of Water-Soluble Oligomers of Hydroxyacids

- William Orts, *NIST, USA*
  Small Angle Neutron Scattering Study of the Chirality and Order in Cellulose and Chitin Liquid Crystals

Noon-1:00 p.m. LUNCH–Woods Restaurant

1:30-4:00 p.m. SESSION 5: **Biodegradation Methods and Environmental Safety Assessments**
Organizers: Graham Swift, Jean Mayer, Chuck Pettigrew, Ann-Christine Albertsson

- Richard Bartha, *Rutgers University, USA*
  Methods of Assessment of the Biodegradation of Polymers in Soil

- Michael B. Freeman, *Rohm and Haas Co., USA*
  The Risks of Risk Assessment for Biodegradable Polymers-Sodium Polyaspartate as a Case Study

- Donald G. Webb, *University of Rhode Island, USA*
  Marine Benthic Toxicity Testing Using Flow-Through Chambers: A Systems Approach?

- Robert J. Larson, *The Procter & Gamble Co., USA*
  Environmental Fate of Biodegradable Polymers: Sewage and Solid-Waste Disposal Considerations

3:00-3:15 p.m. COFFEE BREAK

- Ann-Christine Albertsson, *The Royal Institute of Technology, Sweden*
  Chromatographic Fingerprinting: A Method for Better Understanding Degradative Mechanisms in Different Environments

- U. Pagga, *BASF AG, Germany*
  Biodegradability and Compostability of Polymers– Test Methods and Criteria for Evaluation and Classification

4:30-6:00 p.m. SESSION 6: **Poster Session B**

7:00-10:00 p.m. BANQUET–Woods Restaurant

Saturday, October 14

7:00-8:00 a.m.	BREAKFAST–Woods Restaurant
8:30-9:30 a.m.	SPECIAL SESSION: **Student Presentations for Awardees**
9:30-Noon	SESSION 7: **Regulation and Disposal** *Organizers:* Denise Rutherford, Ramani Narayan, Rolf-Joachin Müller, Steve Goodwin • Werner Bidlingmaier,*Universität Essen, Germany* **Biodegradable Plastics in Composting** • Luc De Baere, *Organic Waste Systems, Belgium* **The Introduction of Bioplastics in Belgium**
10:30-10:45 a.m.	COFFEE BREAK • Tetsuya Hamabe, *Biochemical Industry Division of Ministry of International Trade & Industry, Japan,* and Kazuhiko Fukuda, *Biodegradable Plastics Society, Japan* **Composting Demonstration Project and Japanese Policy and Regulations for Biodegradable Plastics** • Irshad Ahmed, *Booz, Allen & Hamilton, Inc., USA* **EPA Policy on Biodegradable Plastics**
12:15 p.m.	ADJOURN
12:15-1:15 p.m.	LUNCH–Woods Restaurant

Thursday Afternoon, October 12 (4:30-6 pm)

SYNTHESIS AND CHARACTERIZATION

1. Hann, W. M., G. Swift, and P. Zini. (Rohm and Haas Company Spring House, PA, U.S.A.)
Biodegradable Poly(Aspartic Acid) as a Multifunctional Additive for North Sea Oil Extraction Operations

2. Jedlinski, Z., G. Adamus, H. Janeczek, M. Kowalczuk, T. Scherer, and R. W. Lenz. (Institute of Polymer Chemistry, Polish Academy of Sciences, 41-800 Zabrze, Poland)
Biodegradation of Poly(Methyl Methacrylate) Block Copolymers with Aliphatic Polyesters

3. Onyari, J. M., and S. J. Huang. (Polymer Science Program, Institute of Materials Science, University of Connecticut, 97 North Eagleville Road, U-136, Storrs, CT, U.S.A.)
Copolymers Derived from Lactic Acid, Mandelic Acids and Caprolactone

4. Hagino, Y., and S. J. Huang. (Polymer Science Program, Institute of Materials Science, University of Connecticut, 97 North Eagleville Road, U-136, Storrs, CT, U.S.A.)
Chitosan Film Crosslinked with N-Hydroxysuccinimide Activated Ester

5. Lostocco, M. R., and S. J. Huang. (Polymer Science Program, Institute of Materials Science, University of Connecticut, 97 North Eagleville Road, U-136, Storrs, CT, U.S.A.)
The Miscibility of Poly(lactic acid) with Selected Dialkyl Esters and their Analogous Oligoesters

6. Lostocco, M. R., and S. J. Huang. (Polymer Science Program, Institute of Materials Science, University of Connecticut, 97 North Eagleville Road, U-136, Storrs, CT, U.S.A.)
The Synthesis and Characterization of Hydrogenous Poly(Alkylene succinates) and their Perdeuterated Analogues

7. Kim, S. H., and S. J. Huang. (Polymer Science Program, Institute of Materials Science, University of Connecticut, 97 North Eagleville Road, U-136, Storrs, CT, U.S.A.)
Poly(Amide-Ester)s from p-Aminobenzoic Acid

8. Goodner, M. D., and C. N. Bowman. (Department of Chemical Engineering, University of Colorado, Campus Box 424, Boulder, CO, U.S.A.)
Kinetic Modeling of Polymer Networks with Degradable Crosslinks

9. Feil, H., and D. de Wit. (Agrotechnological Research Institute, Postbus 17, 6700 AA, Wageningen, The Netherlands)
Compostable, High Swelling Starch-Based Hydrogels

10. Evans, S. J., T. Hammond, and M. B. Huglin. (Department of Chemistry and Applied Chemistry, University of Salford, Salford M5 4WT, England)
The Modification of Poly(Hydroxybutyrate-Co-Valerate)

11. Cromwick, A.-M., T. Foglia, and R. W. Lenz. (Agricultural Research Service, United States Department of Agriculture, 600 East Mermaid Lane, Philadelphia, PA, U.S.A.)
The Microbial Production of Poly(Hydroxyalkanoates) from Tallow

12. Choe, S., Y.-J. Cha, H.-S. Lee, J. S. Yoon, and H.J. Choi. (Department of Chemical Engineering, Polymer Science and Engineering Research Institute, Inha University, Inchon 402-751, Republic of Korea)
    Miscibility of Poly(3-Hydroxybutyrate-Co-3-Hydroxyvalerate) (PHB-HV) and Poly(vinylchloride) (PVC) Blends

13. Bruno, F. F., J. A. Akkara, D. L. Kaplan, R. Gross, J. S. Dordick, and G. Swift. (U.S. Army Natick RD&E Center, Kansas Street, Natick, MA, U.S.A.)
    Enzymatic Modification of Polysaccharides

14. Babcock, T., H. Goel, J. Otaigbe, and J. Jane. (Iowa State University, 1335 Food Sciences Building, Ames, IA, U.S.A.)
    Making Biodegradable Plastic Articles from Soya Beans

15. Klioutchnikova, N. V., R. A. Gross, and S. P. McCarthy (NSF Center for Biodegradable Polymer Research, University of Massachusetts Lowell, Lowell, MA, U.S.A.)
    Investigation of Sorption Behavior of Polysaccharide-Water System

16. Wang, L., W. Ma, R. Gross, and S.P. McCarthy (NSF Center for Biodegradable Polymer Research, University of Massachusetts Lowell, Lowell, MA, U.S.A.)
    Reactive Blends of Poly(Lactic Acid) and Poly(Ethylene Glycol) II. Diepoxy as Coupling Agent by Extrusion

17. Kumar, R. A., R. A. Gross, and S. P. McCarthy (NSF Center for Biodegradable Polymer Research, University of Massachusetts Lowell, MA, U.S.A.)
    Aqueous Processing of Konjac

18. Levit, M. R., R. A. Gross, and S. P. McCarthy (NSF Center for Biodegradable Polymer Research, University of Massachusetts Lowell, Lowell, MA, U.S.A.)
    Composites based on Poly(Lactic Acid) and Cellulosic Fibrous Materials

Biodegradation

19. Agarwal, M., D. Y. Tseng, K. Koelling, and J. J. Chalmers. (Department of Chemical Eng., The Ohio State University, Columbus, OH, U.S.A.)
    Biodegradation & Characterization of Poly-Lactic Acid Polymer Film in a Composting System

20. N. E.-S. Yousef, and J. A. Cameron. (Department of Molecular and Cell Biology, University of Connecticut, 75 North Eagleville Road, U-44, Room TLS 265, Storrs, CT, U.S.A.)
    Poly(Hydroxybutyrate-Co-Hydroxyvalerate) Depolymerases

21. Chaput, C., A. Leroy-Galissot, L. H. Yahia, A. Selmani, and C.-H. Rivard. (Biomedical Engineering Institute, Ecole Polytechnique, P.O. Box 6079, Stat. Downtown, Montreal, Canada)
    Hydrolytic Degradation of Bacterial PHB/HV Polyesters Under Physiological and Accelerated Conditions

22. Chaput, C., L. H. Yahi, A. Selmani, and C.-H. Rivard. (Biomedical Engineering Institute, Ecole Polytechnique, P.O. Box 6079, Stat. Downtown, Montreal, Canada)
    Biodegradable Porous PHB/HV Materials. A Microscopic, Physical and Mechanical Study

23. Chaput, C., A. Leroy-Galissot, S. Rhalmi, A. Selmani, and C.-H. Rivard. (Biomedical Engineering Institute, Ecole Polytechnique, P.O. Box 6079, Stat. Downtown, Montreal, Canada)
    ***In Vivo* Tissue Reactions and Biodegradation Effects Toward Bacterial PHB/HV Polyesters**

24. Hiltunen, K., M. Härkönen, J. Seppälä, and M. Itävaara. (Department of Chemical Engineering, Helsinki University of Technology, Kemistintie 1, FIN-02150 Espoo, Finland)
The Degradation of Lactic Acid Based Poly(Ester-Urethane)

25. Lehmann, R. G., S. Varaprath, and J. R. Miller. (Dow Corning Corporation, Health & Environmental Sciences, Midland, MI, U.S.A.)
Degradation of Polydimethylsiloxanes in the Soil Environment

26. Fink, A.-B., W.-R. Müller, & A. Schäfer. (Akademischer Oberrat, Institut für Siedlungswasserbau, Wassergüte-und Abfallwirtschaft, Abt. Biologie, Bandtäle 1, D-70569 Stuttgart, Germany)
Biodegradability of Polymers, Comparison of Aerobic and Denitrifying Conditions in Aqueous Systems

27. Jörg, R., and W.-R. Müller. (Akademischer Oberrat, Institut für Siedlungswasserbau, Wassergüte- und Abfallwirtschaft, Abt. Biologie, Bandtäle 1, D-70569 Stuttgart, Germany)
Methanomat, an Automatized Screening Test Device for the Examination of Anaerobic Biodegradation

28. Nakayama, A., N. Kawasaki, S. Aiba, and N. Yamamoto. (Dept. of Organic Materials, Osaka National Research Institute, AIST, 1-8-31 Midorigoaka, Ikeda, Osaka 563, Japan)
Synthesis and Biodegradability of Novel Copolyesters Containing γ-Butyrolactone Units

29. Richards, R., R. W. Lenz, R. C. Fuller, and S. Goodwin. (Department of Microbiology, University of Massachusetts, Amherst, MA, U.S.A.)
Isolation and Characterization of a Versatile Poly(β-Hydroxyoctanoate)-Degrading Bacterium from Compost

30. Rothermich, M., U. D'Ambrosio, R. W. Lenz, R. C. Fuller, and S. Goodwin. (Department of Microbiology, University of Massachusetts, Amherst, MA, U.S.A.)
Poly(β-hydroxyalkanoate) Accumulation by Bacterial Isolates from Stratified Microbial Mat

31. Rothermich, M., U. D'Ambrosio, R. W. Lenz, R. C. Fuller, and S. Goodwin. (Department of Microbiology, University of Massachusetts, Amherst, MA, U.S.A.)
Quantification and Characterization of Naturally-Occurring Poly(β-hydroxyalkanoates) in Stratified Microbial Mat

32. Kouloungis, N. R., R. E. Farrell, S. P. McCarthy, D. Eberiel, and R.A. Gross. (NSF-Biodegradable Polymer Research Center, Lowell, MA, U.S.A.)
Biodegradability of Citrate Ester Plasticizers

33. Levit, M. R., R. E. Farrel, R. A. Gross, and S.P. McCarthy (NSF Center for Biodegradable Polymer Research, University of Massachusetts Lowell, Lowell, MA, U.S.A.)
Biodegradable Plastic-Paper Composites: Influence of Structure on Mechanical Properties and Kinetics of Biodegradation

34. MacDonald, R. T., S. P. McCarthy, and R. A. Gross, (NSF Center for Biodegradable Polymer Research, University of Massachusetts Lowell, Lowell, MA, U.S.A.)
Effects of Stereochemistry and Crystallinity on the Enzymatic Degradation of Polylactide Stereocopolymers

35. Parandoosh, S., R. E. Farrell, R. G. Jackson, R. A. Gross, D. T. Eberiel, and S. P. McCarthy (NSF-Biodegradable Polymer Research Center and University of Massachusetts Lowell, MA, U.S.A.)
Biodegradation of Natural/Syndiotactic Poly(3-Hydroxybutyrate)

Friday Afternoon, October 13 (4:30-6 pm)

SYNTHESIS AND CHARACTERIZATION

36. Espartero, J. L., S. M. Li, I. Rashkov, N. Manolova, and M. Vert. (C.R.B.A., Faculté de Pharmacie, 15, Avenue Charles Flahault, 34060 Montpellier, France)
Insights into [1]H NMR Analysis in the PLA Family

37. Li., S. M., P. Foch, J. L. Espartero, and M. Vert. (C.R.B.A., Faculté de Pharmacie, 15, Avenue Charles Flahault, 34060 Montpellier, France)
More Information from [1]H NMR Analysis of Lactic Acid-Containing Degradable Polymers. The Case of PLACL Copolymers

38. Kylmä, J., M. Härkönen, and J. V. Seppälä. (Department of Chemical Engineering, Helsinki University of Technology, Kemistintie 1, FIN-02150 Espoo, Finland)
The Control of T_g in Biodegradable Poly(ester-urethanes)

39. Lee, K. H., B. S. Jin, and K. S. Yoon. (Deptartment of Polym. Sci. & Tech., Inha University, Inchon 402-751, Korea)
Characterization of Structure and Orientation in Uniaxially Stretched Aliphatic Polyester Films

40. Yoon, K. S., and K. H. Lee. (Dept. of Polym. Sci. & Tech., Inha University, Inchon 402-751, Korea)
Effect of Processing Conditions on Structure and Property of Aliphatic Polyester Blown Films

41. Orava, P. A., M. P. Hiljanen-Vainio, T. Karjalainen, and J. V. Seppälä. (Department of Chemical Engineering, Helsinki University of Technology, Kemistintie 1, FIN-02150 Espoo, Finland)
The Adjustment of T_g of ε-Caprolactone/DL-Lactide Copolymers

42. Reddig, M. A., J. A. Kornfield, and L. A. Schectman. (Chemical Engineering, California Institute of Technology, 210-41, Pasadena, CA, U.S.A.)
Melt Rheology, Stress-Optical Properties and Thermal Behavior of PHBs of Varying Stereo-Regularity

43. Sarbolouki, M. N. (Institute of Biochemistry and Biophysics, Tehran University, P.O. Box 13148-1384, Tehran, Iran)
Synthesis of Poly(DL-Lactide-Co-DL-3,6-Dimethl Morpholine-2,5-Dione)

44. Song, Z., and J.-L. Jane. (Department of Food Science and Human Nutrition, Iowa State University, Ames, IA, U.S.A.)
Graft Copolymerization of Some Vinyl Monomers onto Soybean Proein

45. Stading, M., and A. Leufvén. (Chalmers University of Technology, SIK-the Swedish Institute for Food Research, PO Box 5401, S-402 29, Göteborg, Sweden)
Permeability and Mechanical Properties of β-Lactoglobulin Films

46. Taigel, G., A. Trinkner, and M. Bruckschlegel. (Institut Für Kunststoffprgfung und Kunststoffkunde (IKP), Universität Stuttgart, Pfaffenwaldring 32, D-70569 Stuttgart, Deutschland)
Biodegradable Packaging Materials Physical-Chemical Characterization of PHB/PCL Copolymers by Size Exclusion Chromatrography (GPC) and Mass Spectrometric Detection (GC-MS)

47. Takemura, H., M. Tabuchi, K. Watanabe, T. Tsuchida, Y. Morinaga, Y. Sone, F. Horii, and F. Yoshinaga. (Bio-Polymer Research Co., Ltd., 3-2-1 Sakato, Takatsu, Kawasaki 213, Japan)
Water-Soluble Polysaccharide Produced by Cellulose-Producing Bacteria, *Acetobacter Xylinum* Subsp. *Sucrofermentans* BPR2001

48. Uchida, H., R. Tanaka, T. Kurihashi, and M. Kawashima. (Tsukuba Research Laboratories, 27, Wadai, Tsukuba, Ibaraki, 300-42 Japan)
Biodegradation of Liquid Polymer with Polyethylene Glycol Side Chain

49. Zhang, Q. Q., L. Ren, C. Wang, and L. R. Liu. (Institute of Biomedical Engineering, Chinese Academy of Medical Sciences, P.O. Box 25(204), Tianjin 300192, P.R. China)
Crystallization and Mechanical Properties of PVA-Collagen Composite

50. Tan, I. K. P., E. S. Stuart, R. W. Lenz, and R. C. Fuller. (Department of Polymer Science, University of Massachusetts, Amherst, MA, U.S.A.)
***Pseudomonas oleovorans* Polymerase Flexibility: *In Vivo* and *In Vitro* Evaluation through a Regimen of Co-feeding**

51. Wu, B., T. Scherer, R. W. Lenz, and R. C. Fuller. (Department of Chemistry, University of Massachusetts, Amherst MA, U.S.A.)
Ring-Opening Copolymerization of (R,S)-3-Butyrolactone and 4-Butyrolactone: A Synthetic Route to Bacterial Copolyester

52. van Vilsteren, G., T. Jongsma, and M. Fossen. (Instiyuut voor Agrotechnologisch Onderzoek, Bornsesteeg 59, Postbus 17, 6700 AA Wageningen, The Netherlands)
Fiber Reinforced Caseinate

53. Stenhouse, P., J. A. Ratto, and M. Auerbach. (U.S. Army Natick Research, Development and Engineering Center, Natick, MA, U.S.A.)
Effect of Starch on the Processability, Biodegradation and Mechanical Properties of a Biodegradable Polyester

Biodegradation

54. Hoshino, A., H. Sawada, and M. Kimura. (Biodegradable Plastics Society, 10-5, Shimbashi 5-Chome, Minato-ku, Tokyo 105, Japan)
Field Testing of Biodegradable Plastics

55. Scherer, T. M., S. Goodwin, R. C. Fuller, and R. W. Lenz. (Department of Polymer Science and Engineering, University of Massachusetts, Amherst, MA, U.S.A.)
Fungal Degradation of Aliphatic Polyesters

56. Shaw, K., J. Watts, B. Harrigan, and M. Day. (National Research Council, Building M-12, Room B-22, Montreal Road, Ottawa, Ontario, Canada)
Assessment of the Degradability (Bio-, Thermal and Thermo-Hydrolytic) of a Series of Commercial Degradable Polymers

57. Stote, R., K. Dixon, J. Mayer, and D. Kaplan (Department of the Army, U.S. Army Soldier Systems, Comm& (PROV), Natick Research, Development and Engineering Center, Natick, MA, U.S.A.)
Development of an Accelerated Laboratory Soil System for Polymer Degradation

58. Pranamuda, H., Y. Tokiwa, and H. Tanaka. (National Institute of Bioscience and Human Technology, Tsukuba, Ibaraki 305 Japan)
Microbial Degradation of High-Molecular-Weight Polylactide

59. Torres, A., S. M. Li, S. Roussos, and M. Vert. (Laboratory of Biotechnology, ORSTOM. 911, Av. d'Agropolis, B. P. 5045, 34032 Montpellier, France)
Fate of Lactic Acid Polymers (PLA) in the Presence of Selected Microorganisms

60. van der Zee, M., J. H. Stoutjesdijk, P. A. A. W. van der Heijden, and D. de Wit. (Instituut voor Agrotechnologisch, Onderzock (ATO-DLO), Bornsesteeg 59, Postbus 17, 6700 AA Wageningen, The Netherlands)
Structure-Biodegradation Relationships of Polymeric Materials

61. Yamamoto, N., A. Nakayama, N. Kawasaki, K. Hayashi, and S. Aiba. (Department of Organic Materials, Osaka National Research Institute, AIST 1-8-31, Midorigaoka, Ikeda, Osaka 563 Japan)
Biodegradation of Copolyesteramides

62. Yasin, M., and J. L. Foster. (Aston University, Department of Chemical Engineering and Applied Chemistry, Aston Triangle, Birmingham, B4 7ET, UK)
Polyhydroxybutyrate-Hydroxyvalerate Based Blends: Biodegradation in Extreme Environments

63. Yasin, M., N. Arif, T. Ali, A. J. Amass, and B. J. Tighe. (Aston University, Department of Chemical Engineering and Applied Chemistry, Aston Triangle, Birmingham, B4 7ET, UK)
Multi-Component Biodegradable Polycaprolactone Blends

64. Mitchell, J. M., R. E. Farrell, T. J. Adamczyk, R. A. Gross, S. P. McCarthy, and D. T. Eberiel. (NSF-Biodegradable Polymer Research Center, University of Massachusetts Lowell, Lowell, MA, U.S.A.)
Aerobic Biodegradation of Polymeric Materials in Soil

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Biodegradability of Poly(Lactic Acid) Blends with Poly(Vinyl Acetate) and Poly(Vinyl Alcohol Co-Vinyl Acetate)

66. Paplomatas, J., Th. Evangelou, and C. Panayiotou. (Department of Chemical Engineering, University of Thessaloniki, 54006 Thessaloniki, Greece)
Biodisintegration of Starch and Polyethylene Blends

67. Wheeler, A. P., Y. Tang, P. K. Dighe, and R. J. Ross. (Department of Biological Sciences, Clemson Univeristy, Clemson, SC, U.S.A.)
Bacterial Degradation of Thermal Poly(Aspartate)

68. Snook, J. B., and R. Narayan (Michigan Biotechnology Institute and BioPlastics, Inc., 3900 Collins Rd., Lansing, MI, U.S.A.)
Factors Affecting the Application of ASTM Standard D 5338 to Measure Biodegradability

69. Narayan, R., A. Gustafson, & S. Bloembergen. (EverCorn, Inc., A Joint Venture Company of Japan Corn Starch, Nagoya, Japan and Grand River Technologies/Michigan Biotechnology Institute, 3900 Collins Road, Lansing, MI, U.S.A.)
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